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Extend and Correspondence of
fluctuations in economic factors.

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DEPARTMENT OF TRADE AND COMMERCE
 DOMINION BUREAU OF STATISTICS
 INDUSTRIAL RESEARCH
 OTTAWA - CANADA

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EXTENT AND CORRESPONDENCE OF FLUCTUATIONS IN ECONOMIC FACTORS

In analyses of economic problems it is generally important and often essential to ascertain (a) the extent to which the various relevant factors tend to deviate from their respective long-time trends, and (b) the degree to which fluctuations in the various relevant factors correspond with fluctuations in economic factors generally. In other words, it is important to know how widely the factors fluctuate and how sensitive they are to general business conditions.

(a)

In a publication^(a) of the Dominion Bureau of Statistics on economic fluctuations in the post-war period the deviations from straight-line trend of some three hundred and fifty series are presented from 1919 to 1936, inclusive. For each series the correlation with the deviations in the index of physical volume of business, and the root mean square deviation from trend, have been calculated.

The present bulletin gives the results of the various calculations in summary tabular form with a brief comment on the methods employed and some of the relationships disclosed.

The various series are arranged in the table on page 2 with respect to both measures, viz.: deviation from straight-line trend and correspondence with the index of physical volume of business. Those highly correlated with the physical volume of business are given on the left side of the page, and those less highly correlated on the right side. The series displaying the smallest fluctuations around trend are shown at the top of the page; the more variable range down to the bottom.

The choice of a common standard for comparing correspondence in the fluctuations of individual factors requires some comment. The choice and construction of any such standard has an effect on the correlation of every individual factor with it. For example, a standard which gives more weight to gold shipments would increase the correlation between the standard and gold shipments and decrease the correlation between the standard and, say, general employment, and most other factors. This is so because gold shipments display a negative correlation with most other factors, but since none of the factors correlate perfectly any change in the standard would cause some change in results.

The common standard adopted is the index of the physical volume of business. Like any other such measure, its construction involves a multitude of decisions respecting the selection and weighting of its constituents.

Obviously, any such standard will be subject to differences of opinion, and cannot escape criticism in all details. It is not inconceivable that some sort of an ideal standard might be constructed on purely empirical grounds, along the lines suggested by Dr. E. C. Rhodes in a paper before the Royal Statistical Society,^(x)

(a) Economic Fluctuations in Canada during the Post War Period. Published Jan. 1938.

(x) "The Construction of an Index of Business Activity" (Journal of the Royal Statistical Society, 1937, page 18).

Series Representing Canadian Business Factors, According to Root-Mean Square

Deviation from Trend and Correlation with Physical Volume of Businesses.

Root mean square deviation from trend	over .040	.040-.034	.034-.037	.037-.075	.075-.107	.107-.132	.132-.148	.147-.158	.158-.190	.190-.218	.218-.236	.236-.260	.260-.286	.286-.312	.312-.338	.338-.364	.364-.390	.390-.416	.416-.442	.442-.468	.468-.494	.494-.520	.520-.546	.546-.572	.572-.608	.608-.634	.634-.660	.660-.686	.686-.712	.712-.738	.738-.764	.764-.790	.790-.816	.816-.842	.842-.868	.868-.894	.894-.920	.920-.946	.946-.972	.972-.1000	Root mean square deviation from trend
0-10	<u>Employment-Mfg.</u> Prod. Exports Distribution Carriers Employment-Lumber etc. Employment-Pulp and Paper Employment-Silv.	Mineral Prod. Employment (All) Employment-Freight DRT Employment-Steam Railways C.P.R.-Passenger Carried <u>All Railway-Pass-</u> <u>engers Carried</u>	Employment-Textiles C.H.R.-Passenger Carried	Employment-Print- ing, etc. Employment-Ser- vices	Employment-Mining Bankers-Notice deposits	Boat & Shoe Prod. Linen-Wool Market- ing	<u>Furniture-Mfg.</u> Furniture General Price Con- ditions	Creamery Butter Prod. Ice	Ingested Slaughter- ing	Wholesale Prices Gasoline	Wholesale Prices Gasoline	Interest on Dom- inion Debt	0-10																												
10-15	<u>Manufacturing</u> Prod. Prices C.P.R.-Revenues All Railways Employment-Lumber etc. Employment-Pulp and Paper Employment-Silv.	Coke Prod. Exports C.P.R.-Op. Expenses All Railways Employment-Lumber etc. C.P.R.-Op. Expenses	Coal Prod. Silver Prod. Sales Tax Federal Taxation Re- ceipts C.N.R.-Op. Expenses	Wood Pulp Exports Wholesale Prices Sales Tax Federal Taxation Re- ceipts C.N.R.-Op. Expenses	Employment-Communic- ations Wholesale Prices Sales Tax (Mkt.)	Wholesale Prices Butter Wholesale Prices Cheese Wholesale Prices Eggs Food Klwy. Freight Klwy. Freight-Flour Klwy. Freight-Bitum- inous Coal	Flour Prod. Cattle Slaught'd. Cotton released Emp. Off. Receipts Food Klwy. Freight-Flour Klwy. Freight-Bitum- inous Coal	Ram Toxile Imports Cattle released Emp. Off. Receipts Food Klwy. Freight-Flour Klwy. Freight-Bitum- inous Coal	Sugar Manufactured Shingle Exports Sales Tax Wholesale Prices Producers' Goods Huge Marketing Bank Clearings (Maritime)	Rely. Freight Sugar Sheep Slaughter- ings Hog Slaughter- ings Sheep Marketing Gold Prod. Employment Office Applications	10-15																														
15-20	<u>Industrial Prod.</u> Prod. Bank Securities Klwy. Freight Prices-Minerals C.P.R.-Tolls Carr- ied Ferrous Wholesale Prices Bank Clear's-(Gen.) Bank Clear's-(S.C.) Klwy. Freight-Wool C.N.R.-Op. Revenues C.N.R.-Tolls Carried	Forestry Prod. Timber needed B.C. Imports Veget- able Products Employment-Rubber Klwy. Freight-Rubber Employment-Iron Employment-Met- allic Wholesale Prices Bank Clear's-(Gen.) Bank Clear's-(S.C.) Klwy. Freight-Wool C.N.R.-Op. Revenues C.N.R.-Tolls Carried	Lst Prod. France Clearances Released Paper Imports Bank Clearings Klwy. Freight Bank clearings Petroleum (Canada)	Auto's Imports Clearances Released Bank Clearings Paper Employment-Construc- tion Wood and Imports Employment Mineral Products Lard-Gold Storage Klwy. Freight-Agric- ultural Products	Silver Shipments Tobacco Products Exports Wood and Imports Capitalis s & Allied Products Wholesale Prices Mineral Products Lard-Gold Storage Lard-Gold Storage Klwy. Freight-Agric- ultural Products	Credit Petroleum In- vestments Zinc Prod. Wholesale Prices Lard Chase-Gold Storage holdings Lard-Gold Storage Klwy. Freight-Agric- ultural Products	Iron & Steel Produc- tion Zinc Exports Gres Hogs, Bacon Wholesale Prices Tin Banks-Current loans	Exports Zinc Employment-Metallic Ores Exports Wholesale Prices Northern Exports, Animal Prods. Receipts Klwy. Freight-Oats	Wholesale Prices- Flour Perk Gold Storage Klwy. Freight-Bay and Stras	Banks-Investment Holdings	15-20																														
20-25	<u>Imports</u> Lime Prod. Canadian Emuls Imports Customs Re- ceipts	Lime Prod. Canadian Emuls Imports Customs Re- ceipts	Imports Miscellaneous Asbestos Prod., some Commodities Employment-Ter- ritories & Clothing Autos Bank Clear's-Barley Markets Customs Re- ceipts	Wheat Exports Imports Textiles Exports Vegetable Products Wholesale Prices- Oils	Exports-Planks and Boards Grain Markets Wholesale Prices-Cattle Klwy. Freight-Wheat	Prises-Oats Wheat Markets Wool, raw & yarn, im- ports Cash Price Wheat No.1 Northern Exports, Animal Prods. Receipts Klwy. Freight-Oats	Exports, Cheese Exports, Salmon Federal Sales Tax	20-25																																	
25-30	Crude Rubber Im- ports Building Permits Met Employment-Lab. Transportation Security Prices	Automobile Prod. Copper Prod. Imports Wood and Paper	Banks-Call Loans(other) Exports, Iron and Qd. Revenue	Imports Animal Products Exports, Iron and Products Employment-Building		Exports-Chemicals and Allied Pro- ducts Exports, Non-Ferrous Metals Wholesale Prices- Coal	Exports, Copper Clay Products Prod. Wholesale Prices- Coal Poultry-Gold Storage Veal-Gold Storage	Grand Total Fed- eral Expenditures Pig Iron Butter-Gold Storage Egg-Gold Storage Mutton-Gold Storage	25-30																																
30-35	Iron & Steel Prod. Contracts Awarded Gypsum Prod. Truck Prod. Building Permits (Gen.) Building Permits (Out.)	Contracts Awarded (Construction) Pig Iron Prod. Cement Prod. Imports Iron Security Pr- ices Power & Traction Security Prices	Steel Prod. Immigration from U.S. Pulp and Paper Security Pr- ices Food Security Pr- ices Power & Traction Security Prices	Micel Exports		Exports, Barley Prises-Barley Flax Markets	Employment-Highway Wholesale Prices- Rubber (N.Y.)	Wholesale Pr- ices-Sugar, gran. Beef-Gold Stor- age	30-35																																
35-40	Building Permits Total-Common Stock Prices	Construction Imports-Non-Ferrous Metals	Banks-Call Loans(Canada)		Nickel Prod. Klwy. Freight-Bar, Sheet Iron, etc.	Immigration from U.S.		Dominion Tax on cheques, etc.	35-40																																
40 and over	Building Permits (Same) Iron and Steel Security Prices	Total-Industrial Share Prices Milling Security Prices	Excise Imports Building Permits (Alta.) Immigration-Other Shares traded (Montreal)		Rye Markets	Building Permits, Nova Scotia	Building Permits, New Brunswick	Petroleum Prod. Exports, Textiles Exports-Pulp, paper, etc. Wholesale Pr- ices-Pulp Grain Prod. Oats Market	Wholesale Pr- ices-Mineralian- commodities Basic Nat Basic Nat (N.Y.) Basic disputes ex- isting Wholesale Pr- ices-Pulp Grain Prod. Oats Market	40 and over																															

Note:- Series which are aggregations of other series in the table have been distinguished by underlining.

which would undertake to isolate and measure the movements of causes common to all factors in the economic complex. However, even in such a standard as that one would have to exercise discretion in the selection of series which were to form the constituent parts of the index. Further, since it would involve the calculation of innumerable co-efficients of correlation, the task of construction would be very great. In any case, it is not the purpose of this paper to undertake a critique of a general index of business activity. The physical volume of business index as used by the Bureau of Statistics is accepted. Further, although no two standards would give identical results, so long as the standards were constructed on a reasonable basis the results would be substantially the same for a study of this type; its conclusions are not so subtle as to be seriously affected by the choice of standard.

The long-term trends, it should be noted, are eliminated at the beginning of the calculation and the correlation coefficients measure mainly the correspondence in the major deviations from trend, i.e. the changes which are commonly referred to as cyclical. In comparison with the larger variations such as the drop in the physical volume of business from 1929 to 1933, which constitutes a part of the cycle, the irregular year-to-year changes affect the correlation by very little. The same applies in the measure of variation adopted. Thus, the correlations measure the degree of correspondence in phase and frequency of a number of factors moving in (similar or different) cyclical processions. The "standard deviations" refer then to amplitudes.

For the present study straight-line trends have been fitted to all series. A more meticulous investigation might in some cases require the fitting of other curves as more appropriate to particular series.

The distribution of the various series under review according to their correlation with the physical volume of business is summarized in the table below. It is well known that the difference between a correlation of .90 and .95 is far more significant than the difference between .10 and .15. To give effect to this fact in the chart unequal intervals were used, the division points being in fact a sequence proportional to the first approximation probable errors at the different levels of correlation. This has the additional advantage of preventing a bunching in the cells of high correlation. It will be noted that about ninety per cent of the series show a positive correlation (and one-fifth are above .90). Some such correspondence would, of course, be expected since on purely rational grounds different economic series would be expected to show a tendency to move together. However, the extent of the correspondence is very striking as compared with a random distribution.

If 100 random series were taken and the series which represented their average ascertained, the correlations of each of the component series with the average would in some cases be plus and in other minus in about equal numbers. Owing to the fact that the average would be weighted to the extent of one part in a hundred by each of its component series, there would be a slight tendency for the correlations to group not about zero but about a small positive number (say .01), and they would be distributed with moderate symmetry about this point. In a 19-year series such as we are using where the probable error of the coefficient of correlation is considerable, they would spread over a fairly wide area, so that less than fifty-five^(a) per cent would be positive and the remainder negative.

(a) Using the formula for the standard deviation of a coefficient of correlation $\frac{1-r^2}{\sqrt{N-1}}$ and taking N equal to 19, and assuming that the error of the coefficient of correlation is distributed in Gaussian form.

The actual distribution of the 249 series under review, given below, is very different: -

	Basic Indexes	Aggregate Indexes	Total
+ .949	16	10	26
.949 - .894	30	7	37
.894 - .837	18	2	20
.837 - .775	19	1	20
.775 - .707	15	-	15
.707 - .632	8	1	9
.632 - .548	20	3	23
.548 - .447	17	2	19
.447 - .316	15	3	18
.316 - .000	30	5	35
.000 - .316	10	-	10
.316 - -1.000	16	1	17
Total	214	35	249

The median correlation is .62, the upper and lower quartiles .86 and .28, respectively.

Turning now to the more detailed examination of the main table; following are observations with regard to its more prominent features. It will be understood, of course, that an exhaustive treatment would involve a detailed examination of the whole field of Canadian business.

1. Those series which are aggregations of other series, - such as Manufacturing Production, Mineral Production, Total Imports and Total Exports, etc., - show higher correlation with the physical volume of business than any of their component series, e.g., Boot and Shoe Production, Copper Output, Wheat Exports. This is not particularly significant since a similar result would be obtained even if all the series were uncorrelated.

2. There is no evidence in the table of a grouping about either diagonal, i.e., variability and correlation with business activity are uncorrelated. It cannot be said from the evidence here that series of large emplitude of swing are more or less typical of cyclical changes than series of small amplitude of swing.

3. Of the Employment series 65 per cent are in the first two rows of variability, against only 40 per cent of all series, indicating a tendency for employment to remain relatively constant through the trade cycle, as compared with the other factors, - production, exports, etc. While their fluctuations are small, however, high correlations indicate that they are in phase with the fluctuations of the physical volume of business. Employment on highway construction is a conspicuous exception, being high in its variability from trend and virtually zero in correlation. The non-correlation suggests that the policy of road-building authorities of spreading work over the cycle is fairly widespread. Ontario and Quebec expenditures on highway construction and maintenance, for example, in the years ended October 31st, 1930 - 1937, do not bear any close relation to the general cycle.

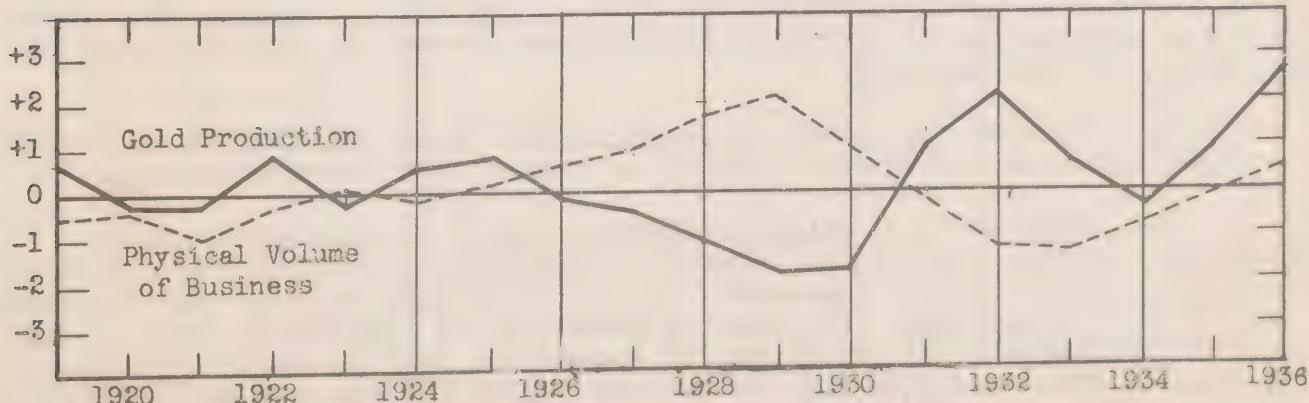
<u>Year</u>	<u>Quebec</u> \$	<u>Ontario</u> \$	<u>Year</u>	<u>Quebec</u> \$	<u>Ontario</u> \$
1929	9,815,361	35,935,547	1934	8,906,334	43,527,504
1930	14,775,552	39,053,165	1935	10,336,871	18,261,393
1931	14,742,675	35,448,494	1936	15,056,480	26,971,466
1932	19,635,982	27,509,002	1937	11,547,775	24,482,447
1933	13,247,693	16,663,857			

4. Showing conspicuous negative correlation with the physical volume of business were Employment Office Applications and Strikes and Lockouts. This verifies the reasonable belief that these factors run counter to the general business cycle. Two forces operate on Employment Office Placements, one drawing it in the same direction, and the other contrary to the direction, of the physical volume of business. The former acts because the placement of a given applicant is easier in good times than in bad, and the latter because the facilities of the office are used more in bad times than in good. As a result a small positive correlation, intermediate between General Employment and Employment Office Applications, is shown.

5. Most of the series referring to activity in the construction industry are in the three columns of highest correlation. They are also in the rows of highest deviation from trend, as is to be expected from the highly variable nature of building activity, which is much subject to speculative influences. Exceptions to the general high correlation are the construction industries of the Maritime Provinces, which show less than .50. Rise and fall in building in the Maritime Provinces are apparently not closely related to business activity in the rest of Canada.

6. Foreign trade in some commodities (crude rubber and bauxite imports are outstanding) is highly correlated with business conditions, while in others (copper, cheese, salmon, exports) it was less susceptible to cyclical influences. Imports showed higher correlation than exports, and both exports as a whole and imports as a whole showed higher correlations than were shown in exports or imports of any single commodity. The variations from the cyclical curve in individual commodities cancelled out to a large extent in the aggregate.

7. Gold production and gold shipments both have a negative correlation of more than .7, indicating not merely a failure to run with business but a significant tendency to be high when business is low, and vice versa, as the chart of gold production below shows.



8. In a surprising number of commodities prices show no significant correlation with the trade cycle. During much of the period the total index of wholesale prices moved with the physical volume of business, but there was no reflection in business activity of the rise in the price index in 1920. The situation in that year was complicated by the decline of agricultural production, which considerably lowered the index of the physical volume of business. Taken over the whole period general prices has a correlation of only .29, but eliminating the first two years brings this measure to nearly .50.

Exceptions to the general rule are copper and furs, which correlate over .8. An investigation might well be performed for Canada classifying commodity prices as responsive or not to changes in the physical volume of business, and finding the other factors, e.g. weather, etc.

9. A conspicuous exception to the statement that prices are uncorrelated with the business cycle is offered by the prices of securities, common stock prices having a correlation of .96 with the business cycle, and ten out of eleven of its components ranking over .84.

10. Assets and liabilities of the banks do not vary with the phase of the business cycle. Canadian call loans, however, which have a correlation of .89, occupy, with building and construction and volume of shares traded at Montreal, the spaces of the greatest variation. Bank clearings in the various cities will be noticed to correlate very high.

11. Five of the seven series of indicators of railroad prosperity correlate .9 or higher with the physical volume of business, and the other two are over .85. It is easy to understand these high correlations, since the railways carry a more or less constant proportion of all production. On the other hand, the traffic through Canadian canals seems to be quite unrelated to the business cycle.

12. Customs receipts and excise income of the Dominion Government are highly correlated, but not income or sales taxes, the latter being nearly independent. Before inference is drawn from these, however, account must be taken of the changing rates of the various kinds of taxes, with changing governmental policy.

13. Foodstuffs, Boot and Shoe Production, and Sugar Production, three important indicators of a certain type of consumer purchases, combine the characteristics of low standard deviation and low coefficient of correlation. Their variation, as is to be expected on theoretical grounds, is small, and tends to be independent of the trade cycle. They may be regarded as forming a part of a large group of non-durable consumers' goods, the demand for which is inelastic in the long run, although it may be affected over a very short period by postponement of purchases or buying in advance of immediate needs.

14. Sheep and hog slaughterings run counter to the physical volume of business with rather low variability. Marketings show similar characteristics.

15. There is only a slight tendency for the various aggregated series, Manufacturing Production, Mineral Production, Foodstuffs Production, etc., to show less variability than their components. From a theoretical point of view there are two possible extreme cases: (1) when the series are all independent, that is, when each is dominated only by its own specific tendencies, then an average would have considerably less variability than its components; and (2) when the series are all intercorrelated perfectly, the aggregated series would have the same variability as each of its components. The cases here studied seem to conform more closely to (2) than to (1).

16. An interesting non-correlation is the case of wholesale building material prices. Situated in the lowest classification of variability, and having virtually no relation to the business cycle, they are in sharp contrast with the indexes of construction, which are extremely variable, and highly correlated with business.

The material in this summary is presented in hope that it will prove of use to economists and business investigators in many special fields as exhibiting some of the available data on business fluctuations in the post-war period, and as supplying an arrangement by which any specific barometric index is shown in its relation to economic variations.

Among general conclusions which a first study of the table indicates, are the non-correlation of most price series with the volume of business index; the inverse relation of gold shipments; the lower correlation of exports than of imports; and the particularly low correlations of exports of certain important agricultural and mineral products; the low variabilities in employment in most industries as compared with production; the extreme fluctuations in construction activity.

Finally, the assembly of this wide variety of data emphasizes the cohesion of the economic complex and the pervasive influence of common causes. At the same time the diversity of the reactions of different elements in the complex demands recognition of its essentially pluralistic nature and necessitates a clear understanding of individual phases as a prerequisite to the making of valid and useful generalizations.

